

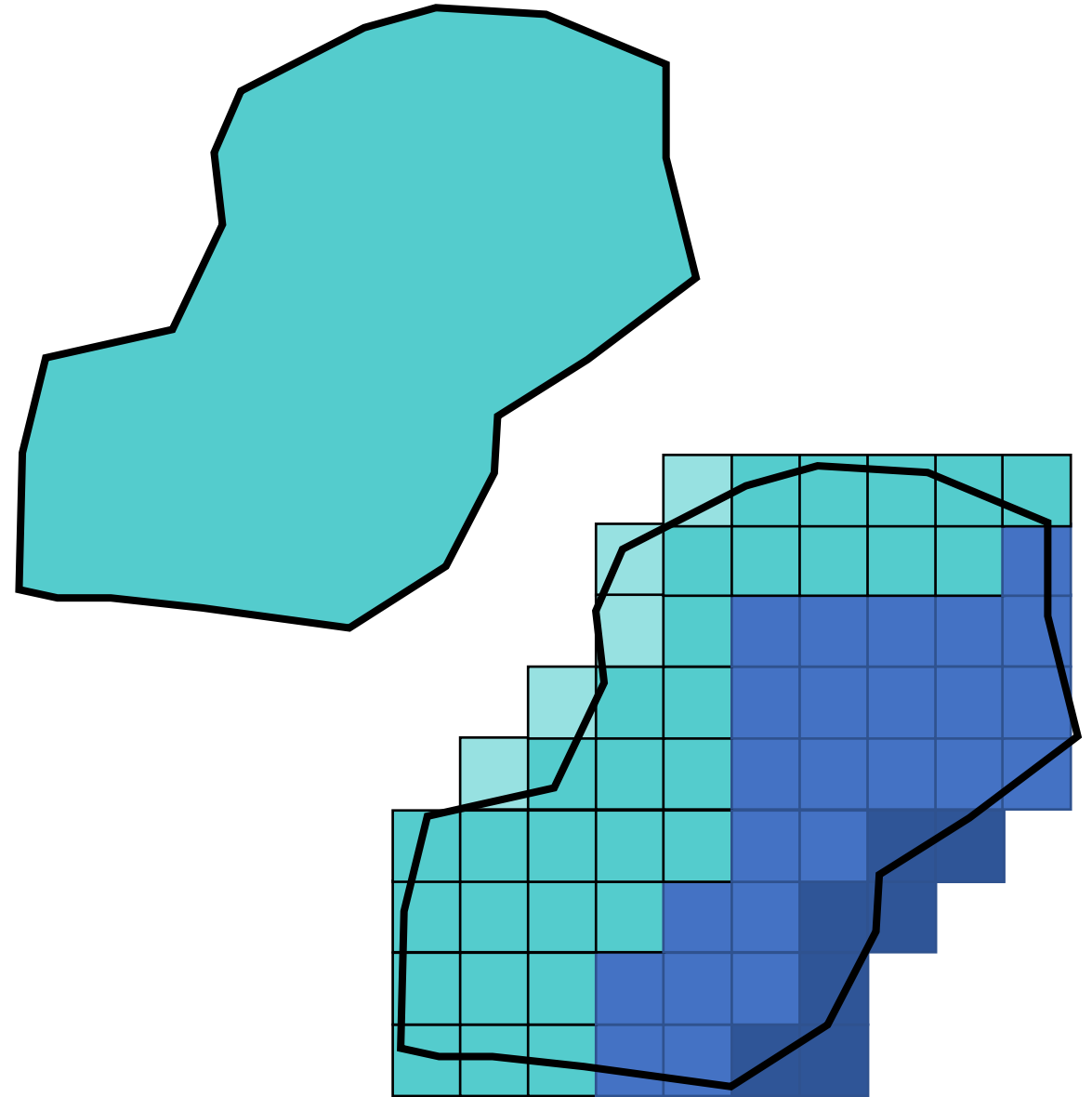
40 Years of Hydroclimatic Change (Or Lack Thereof) Over the Lake Erie Basin

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Contributions From:
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Dr. Yang

Climate change in the Great Lakes

- Climate change often evaluated for an entire watershed
- Assumed to be uniform across large areas but are localized phenomena
- Climate change research often focuses on a few indices on broad scale



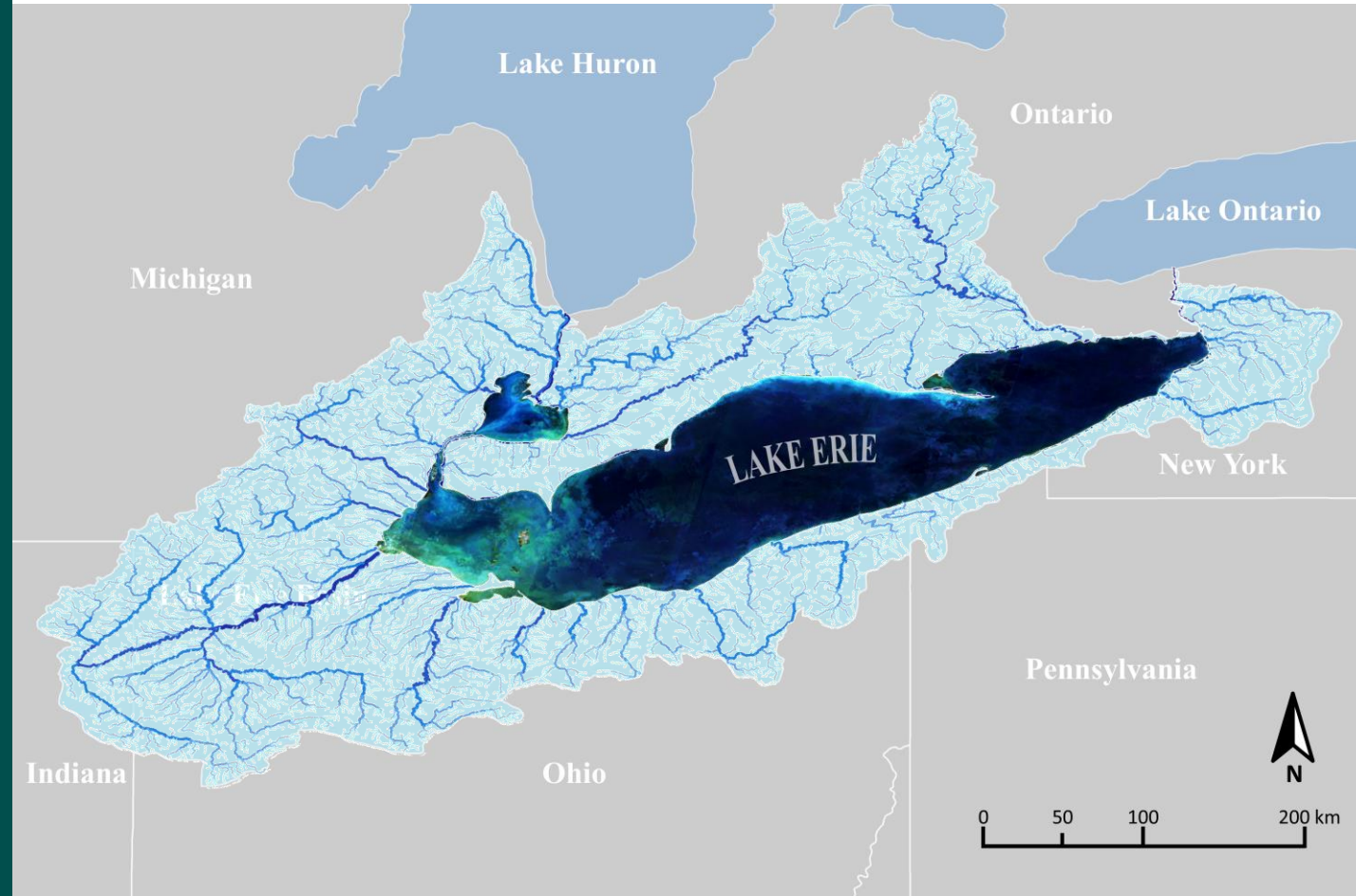
Climate change in the Great Lakes

- Climate change is a driver for flooding events
- Climate change is a driver for eutrophication and algal blooms are often runoff driven
- Research Objective
 - Identify locations within the Lake Erie Basin where there is a presence or absence of a trend in climate indices.
 - Where in the Lake Erie Basin are there changes in climate indices over the last 40 years?



Lake Erie and its Basin

- Provides various ecosystem services such as recreation, habitat and biodiversity
- Drinking water for over 11 million people
- Basin ~ 78 000 square kilometres
 - Several major sub-basins
- > 50 000 square kilometres of agricultural land

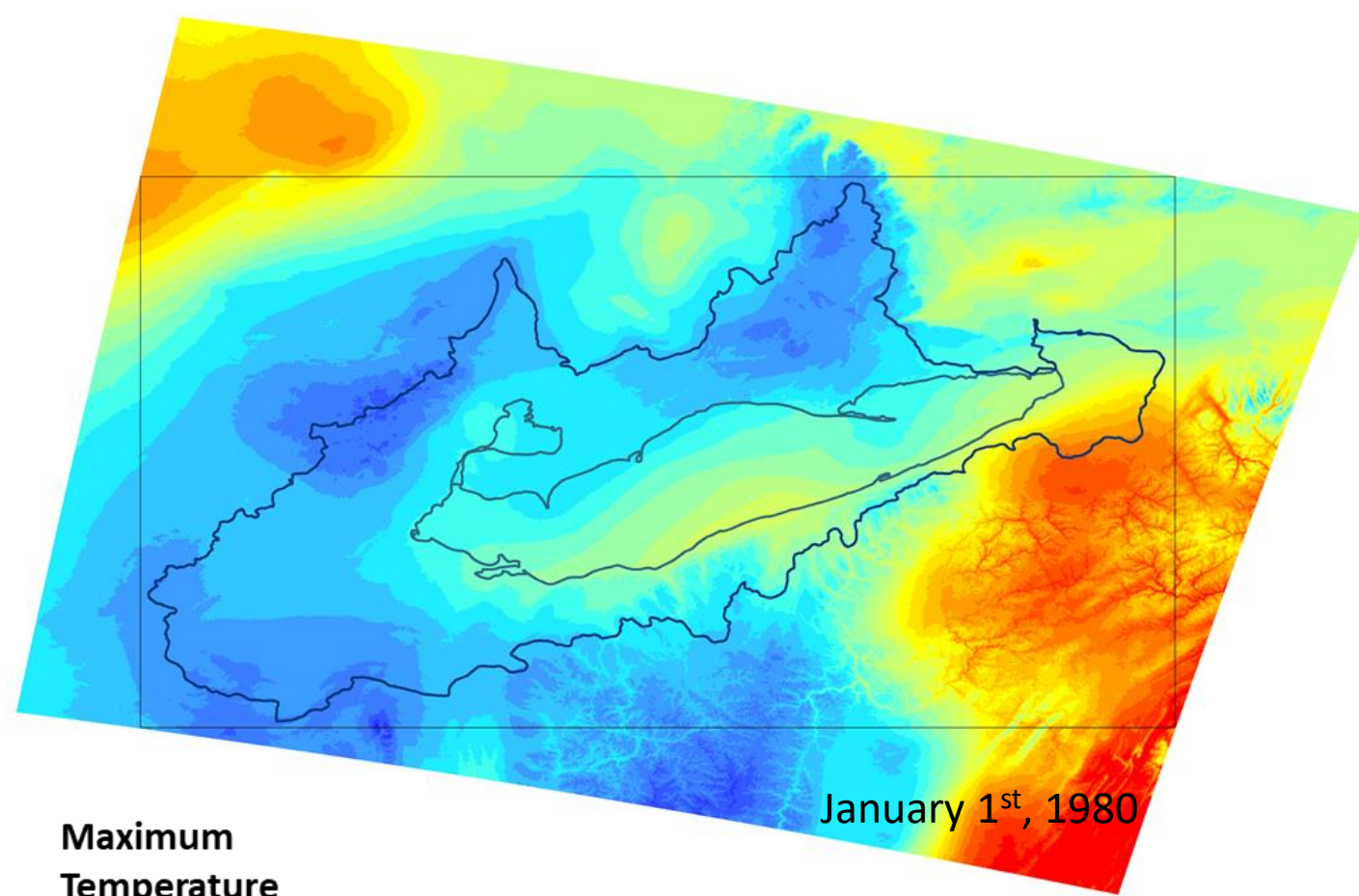


Data

- Daymet Technical Overview

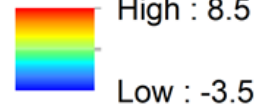
- Source: Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC)

Data Capture	1980 – 2019
Spatial Resolution	1km * 1km
Temporal Resolution	Daily
Variables	<ul style="list-style-type: none">• Day length (s/day)• Precipitation (mm/day)• Shortwave radiation (W/m²)• Snow water equivalent (kg/m²)• Maximum air temperature (degrees C)• Minimum air temperature (degrees C)• Water vapor pressure (Pa)



January 1st, 1980

**Maximum
Temperature
Value**



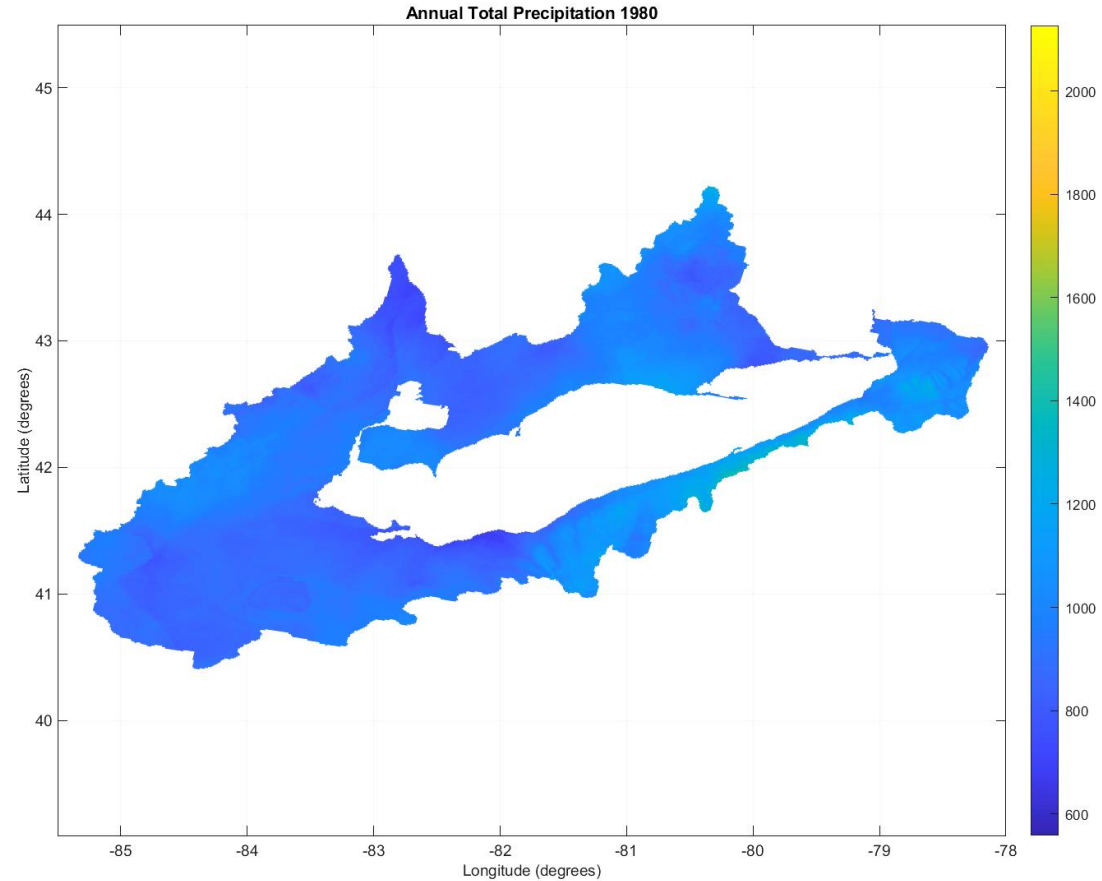
High : 8.5
Low : -3.5

- Lake Erie Basin
- Lake Erie
- Daymet Box

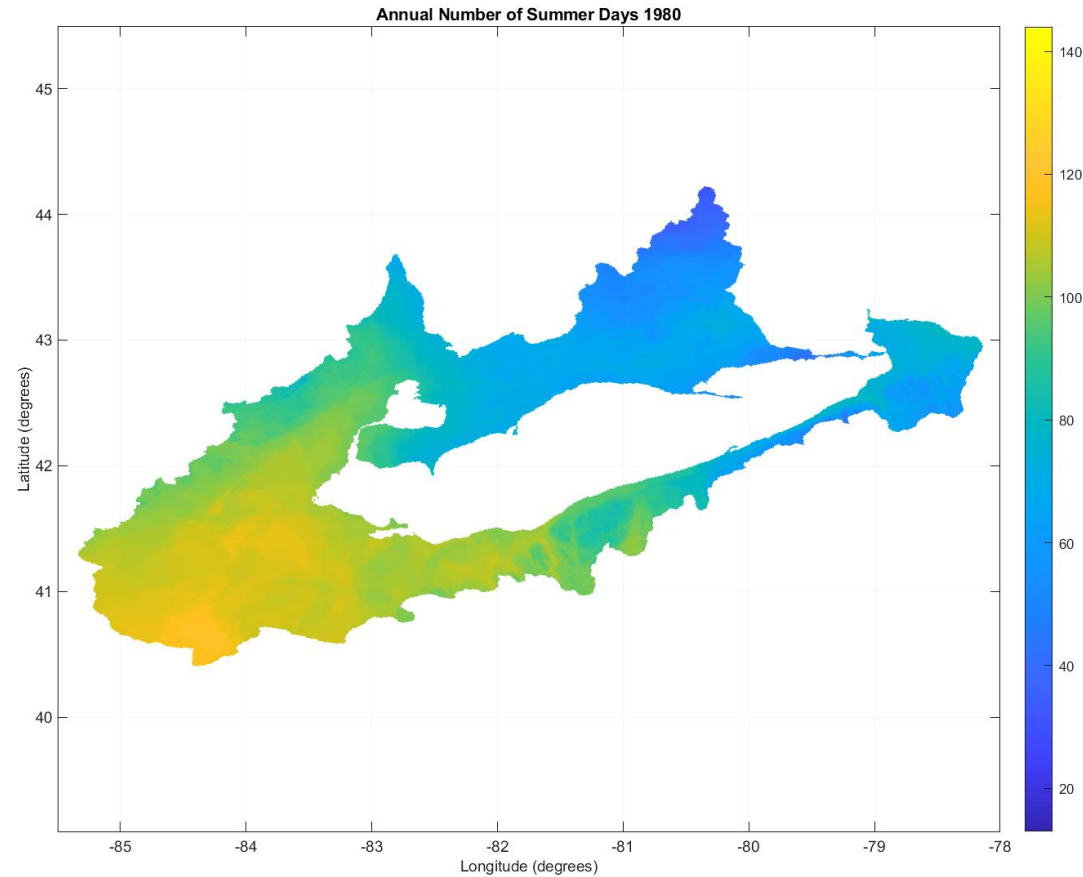
Climate Indices List

Precipitation			Temperature		
Indicator (acronym)	Definition	Timescale	Indicator (acronym)	Definition	Timescale
Total Precipitation	Sum of all precipitation	Annual, Seasonal	Growing Season Length	Count between first span of at least 6 days with daily mean temperature >10°C and first span after July 1st of 6 days with <10°C	Annual
Simple precipitation intensity index (SPII)	Sum of precipitation on wet days / number of wet days	Annual	Frost Days	Number of days where the minimum temperature ≤ 0°C	Annual
Heavy Rainfall	Days where precipitation > 30 mm	Annual, Seasonal	Summer Days	Number of days where the maximum temperature ≥ 25°C	Annual
Maximum Dry Spell Length	Maximum number of consecutive days where precipitation is ≤ 0.2mm	Annual	Freeze Thaw Events	Number of times the minimum temperature switches between <0°C and >0°C	Annual, Seasonal
Rain on SWE	Number of days where rainfall >2mm on SWE	Annual	Minimum Temperature Low	The minimum daily air temperature low (°C)	Annual
Maximum SWE	Maximum amount of water contained in the snowpack (kg/m ²)	Annual	Maximum Temperature High	The maximum daily air temperature high (°C)	Annual

Climate Indices – Annual Total Precipitation



Climate Indices – Annual Number of Summer Days



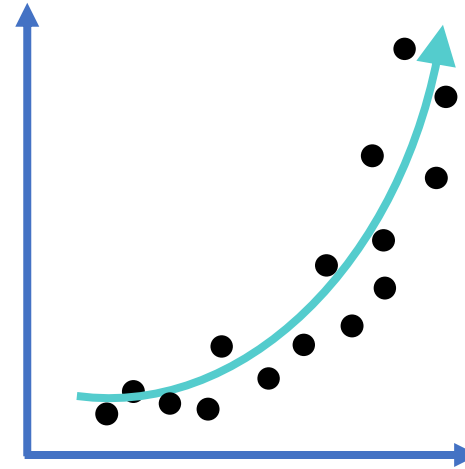
Methodology

Mann Kendal

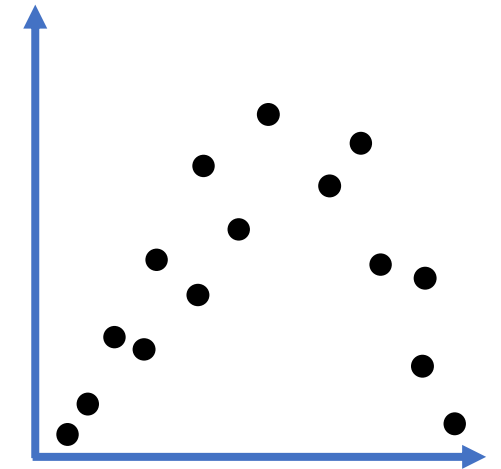
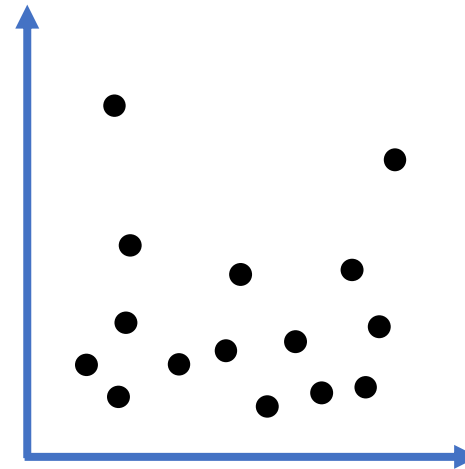
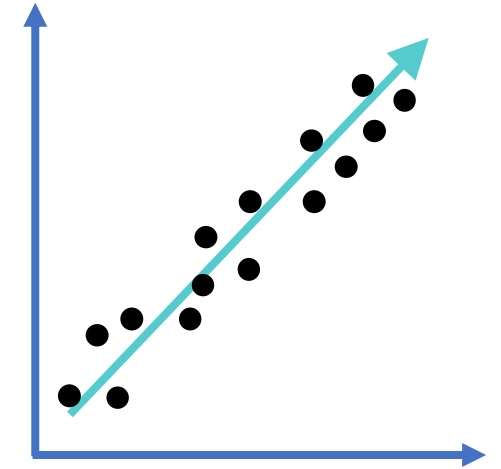
- Trends

- Assess a set of data points to determine if the values are decreasing or increasing
- $S = \sum_{k=0}^{n-1} \sum_{j=i+1}^n \text{sign}(x_j - x_i)$
- Matlab
- Threshold for significance values set at both $p=0.05$ and $p=0.10$

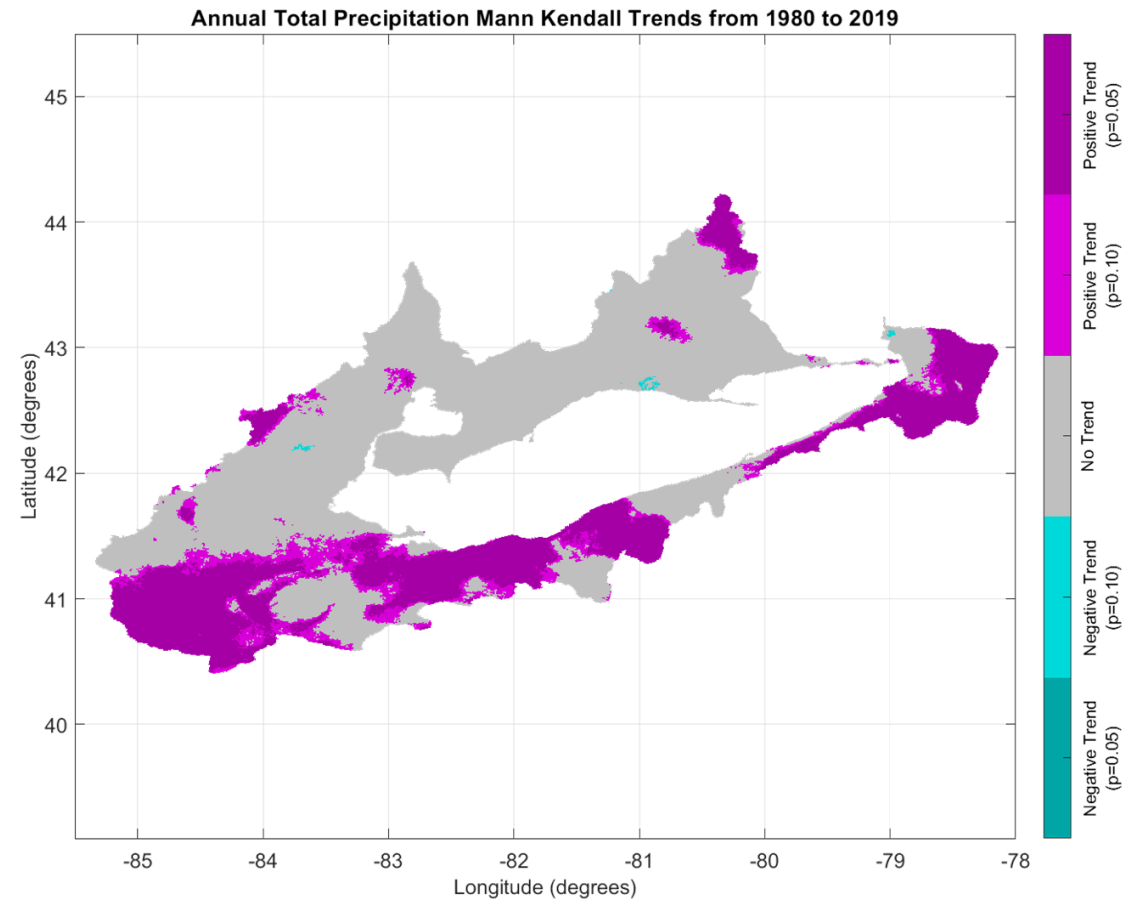
Monotonic



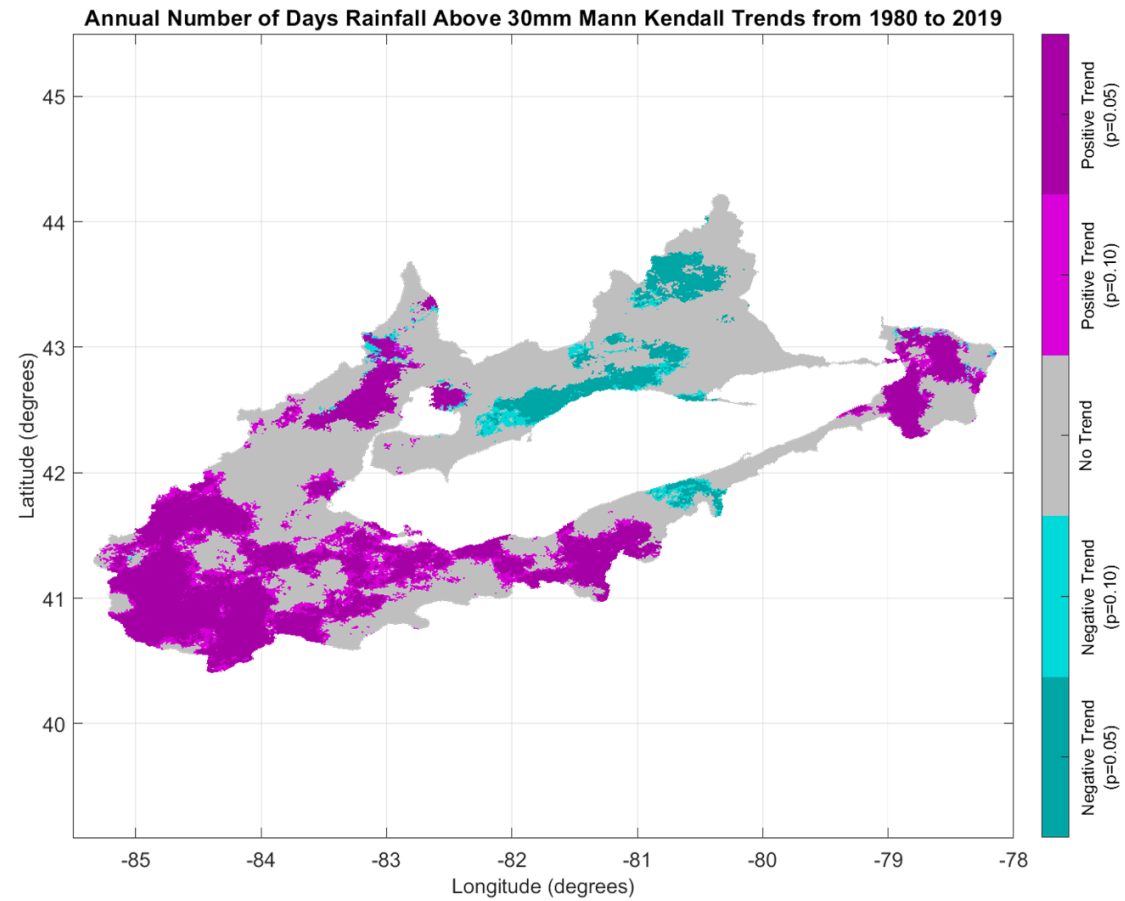
Monotonic & Linear



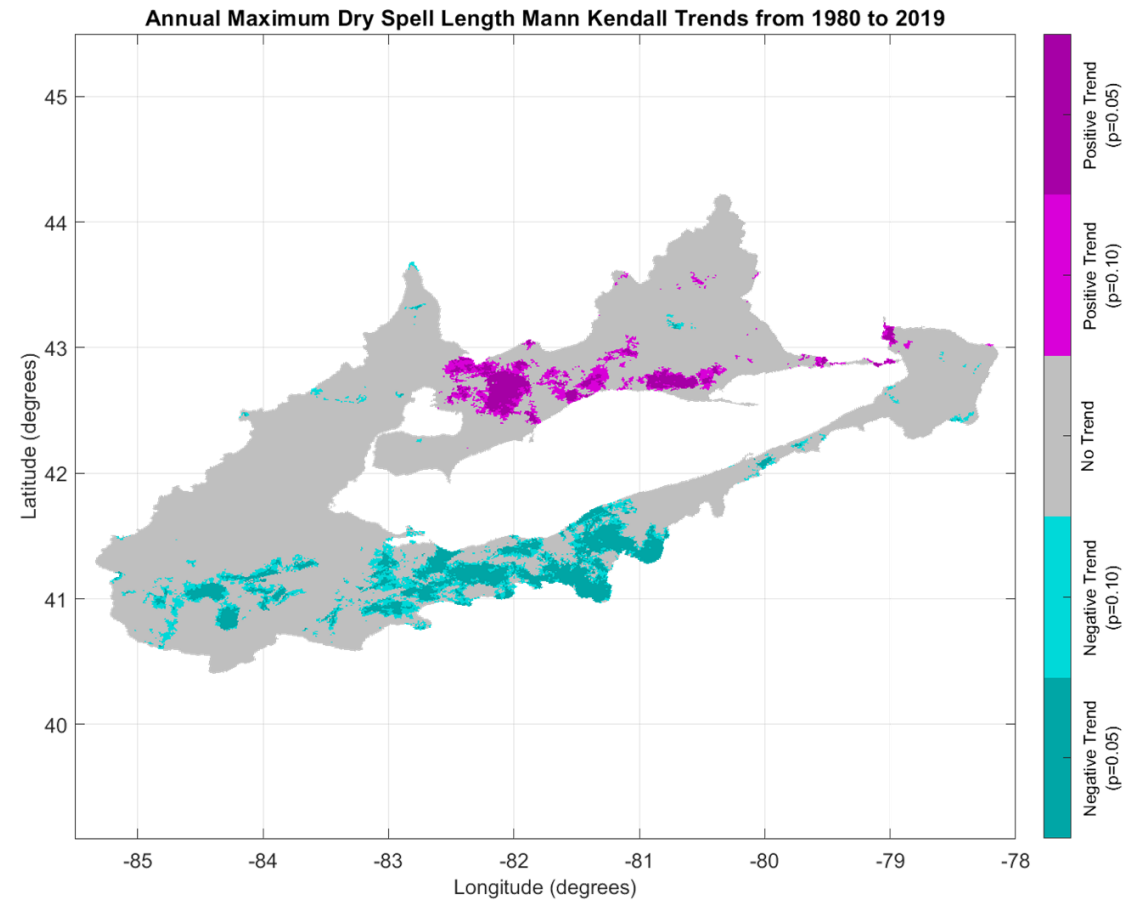
Results



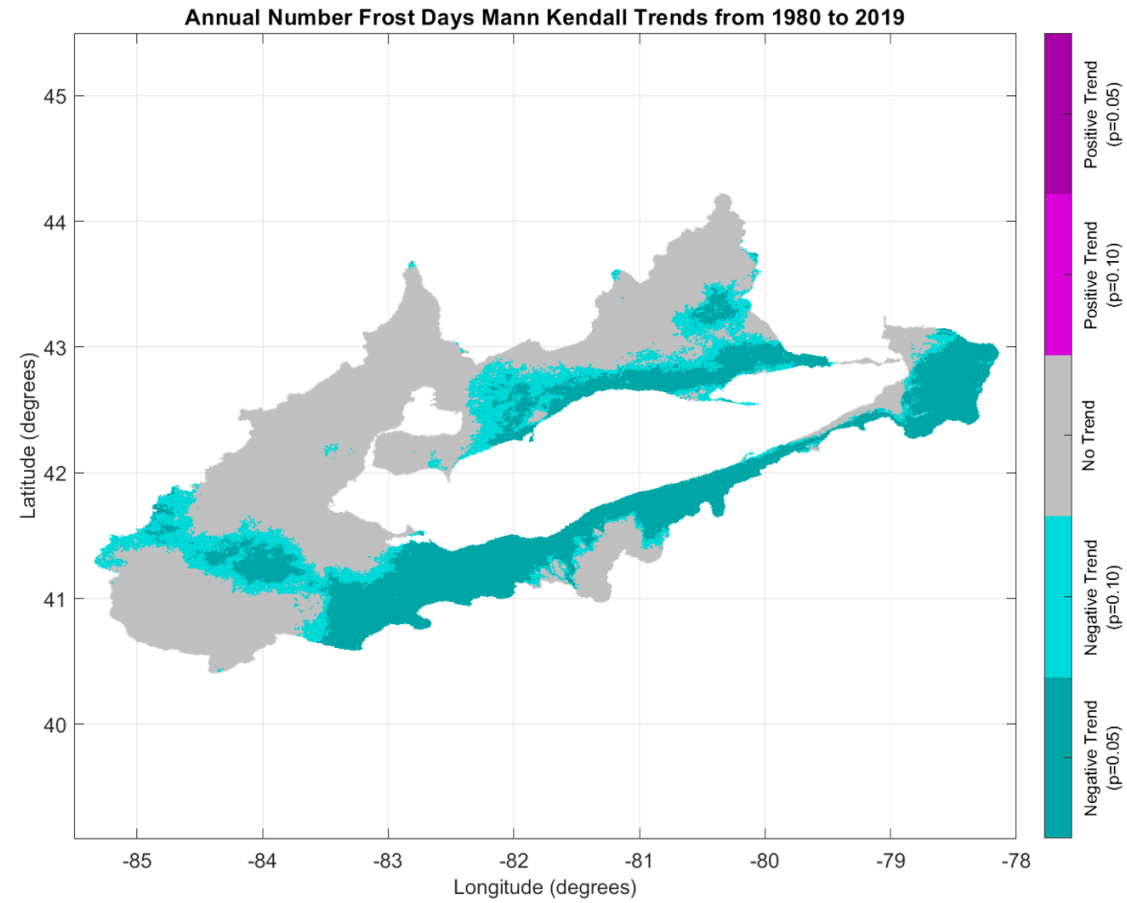
Results



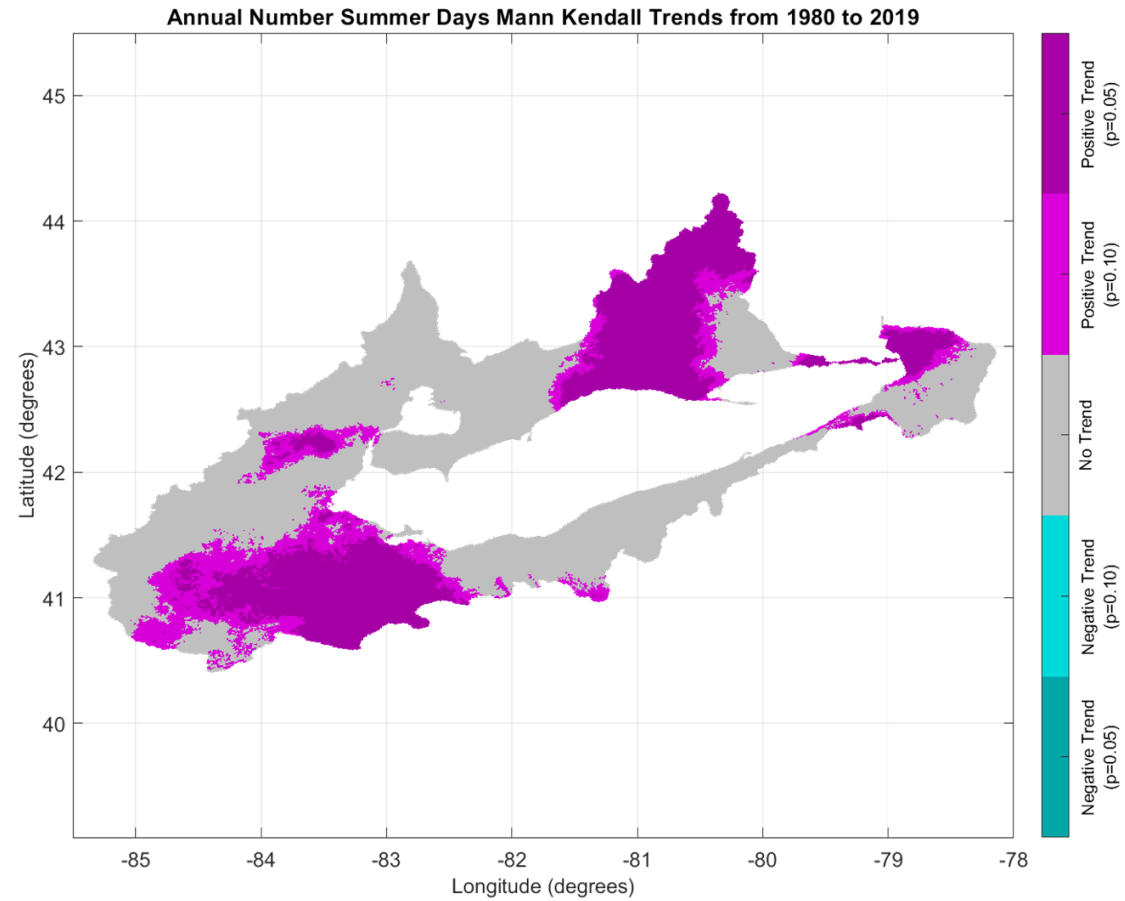
Results



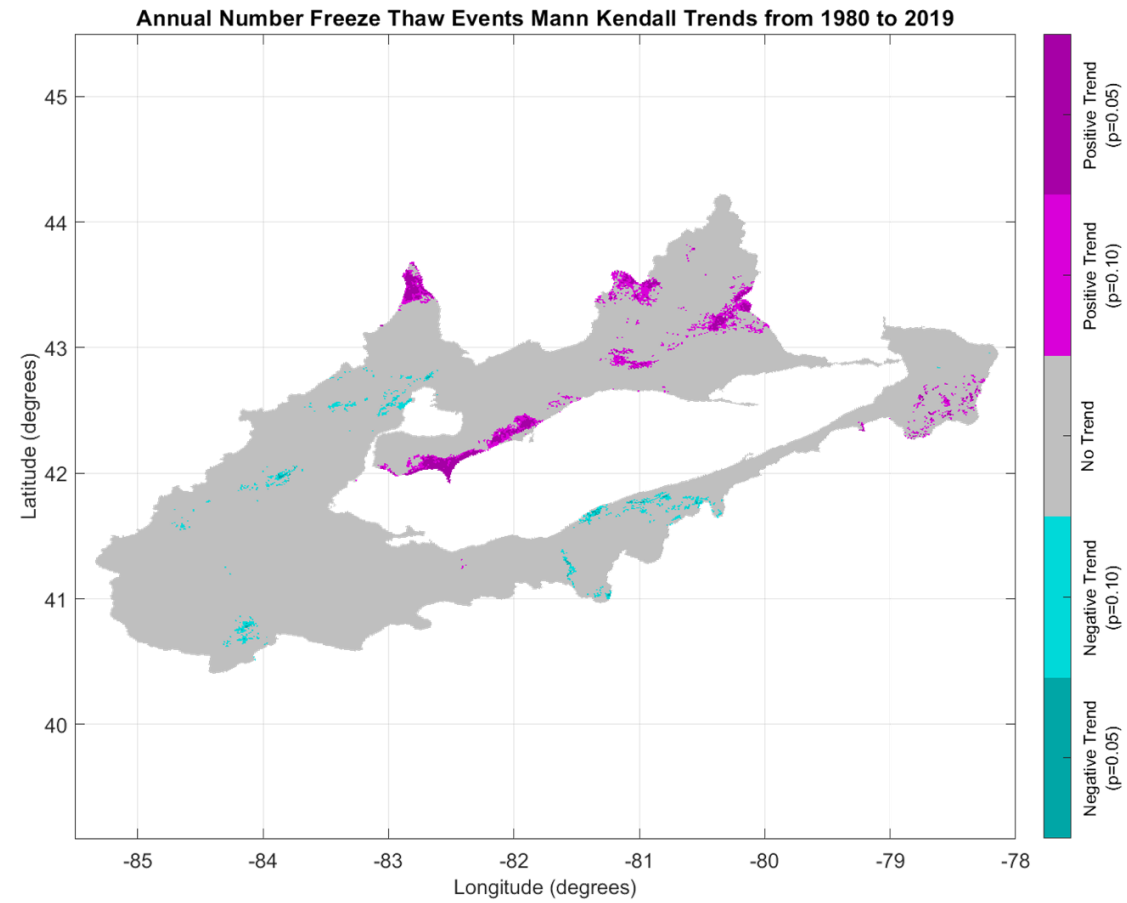
Results



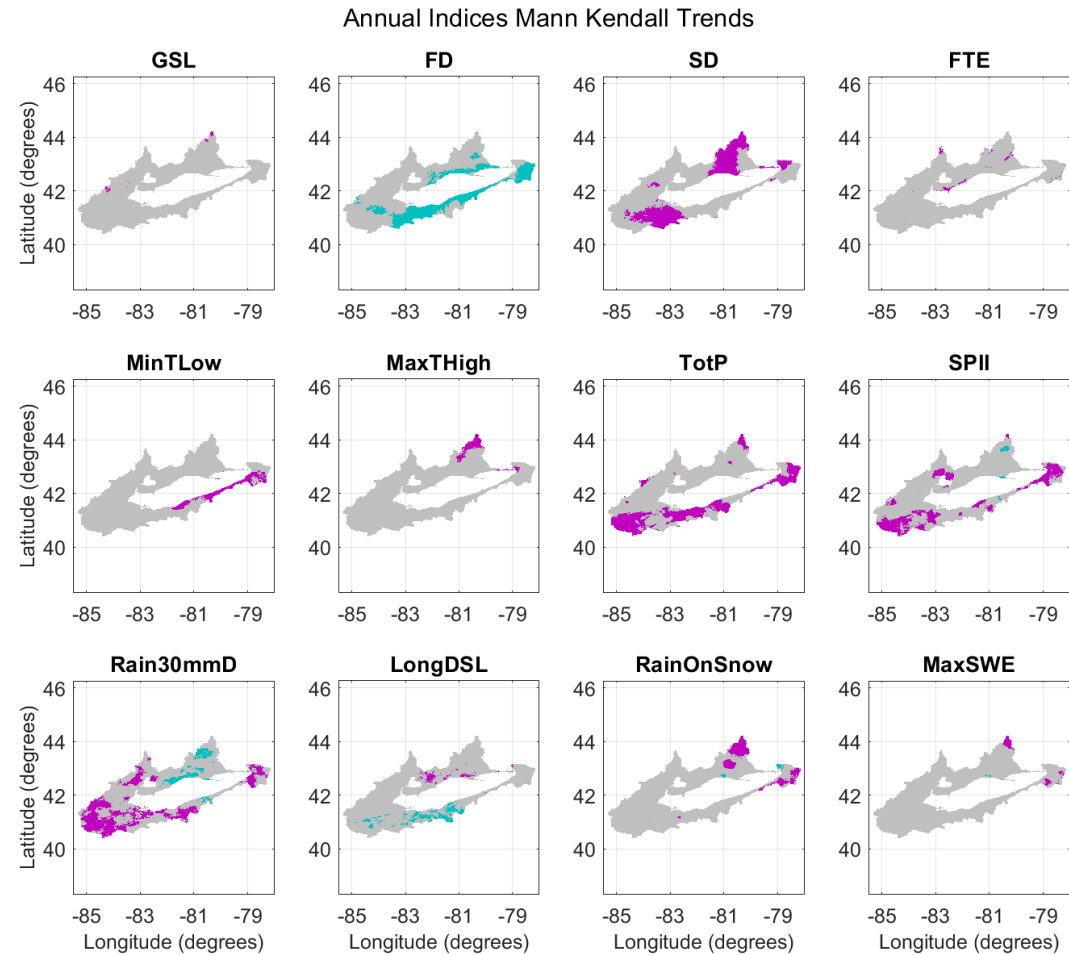
Results



Results

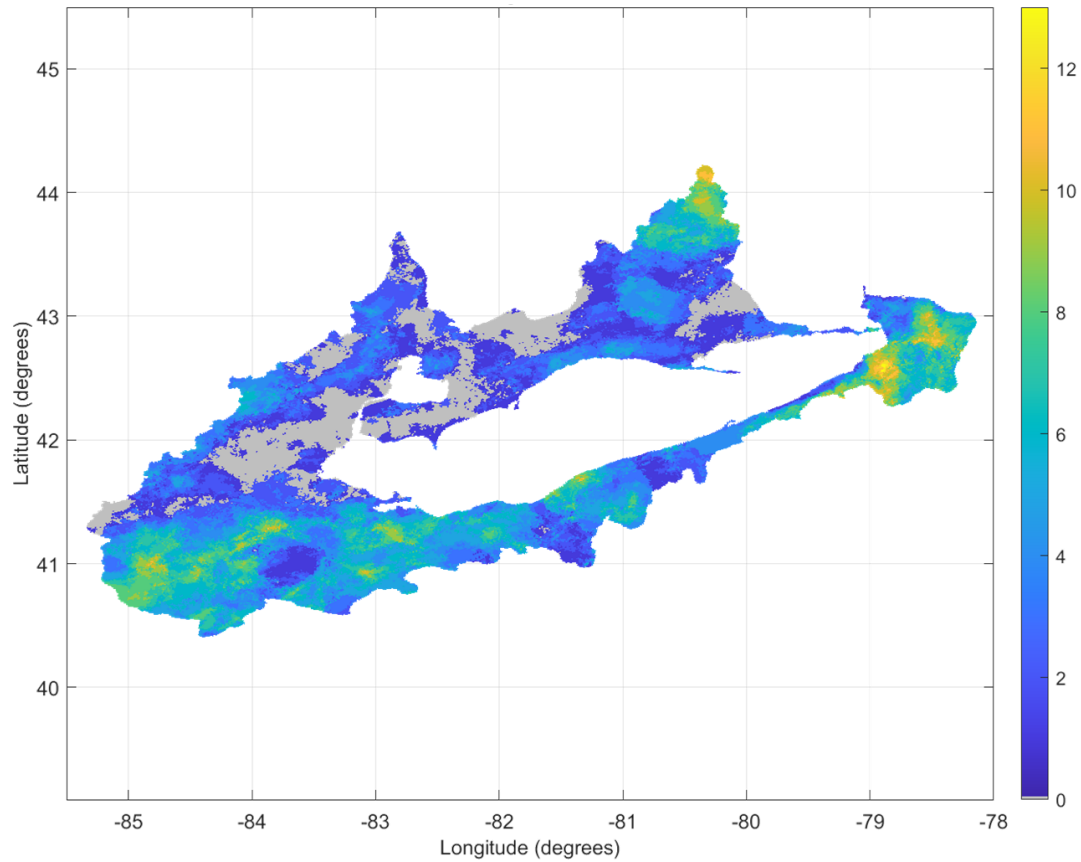


Results

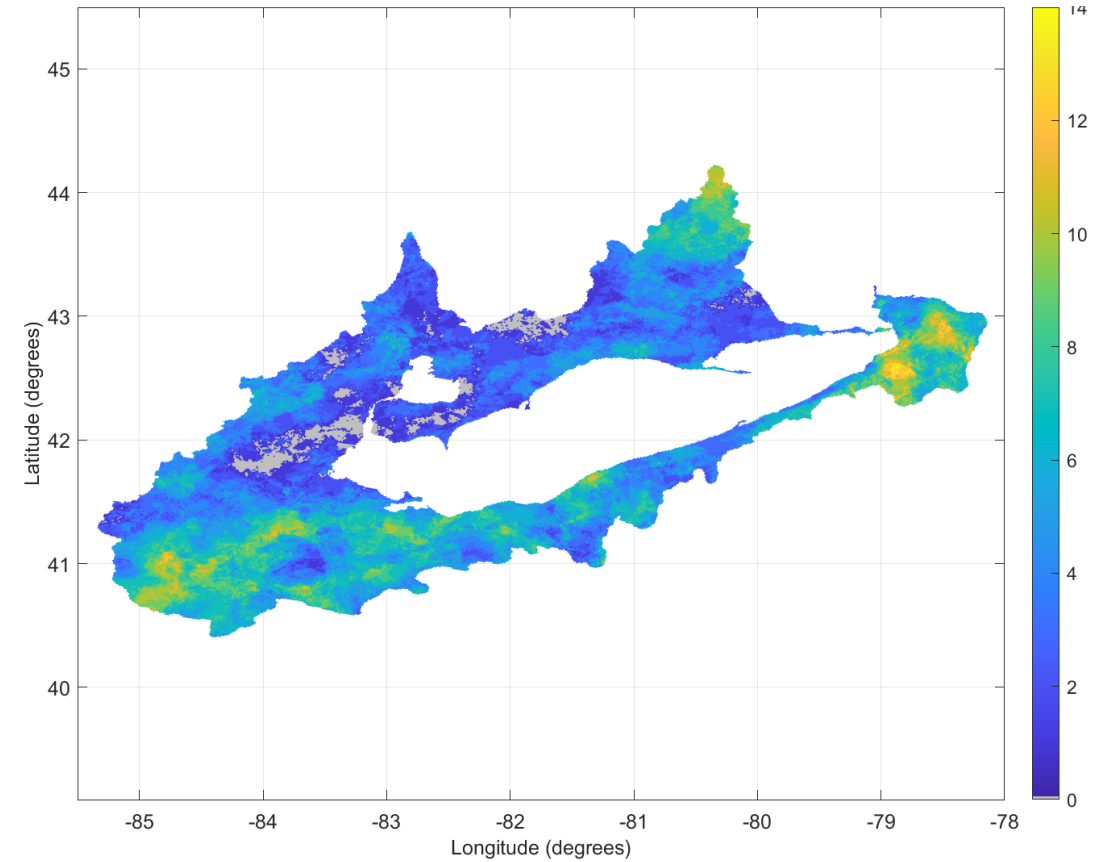


Results

Number of Indices with Significant ($p=0.05$) Mann Kendall Trends



Number of Indices with Significant ($p=0.10$) Mann Kendall Trends



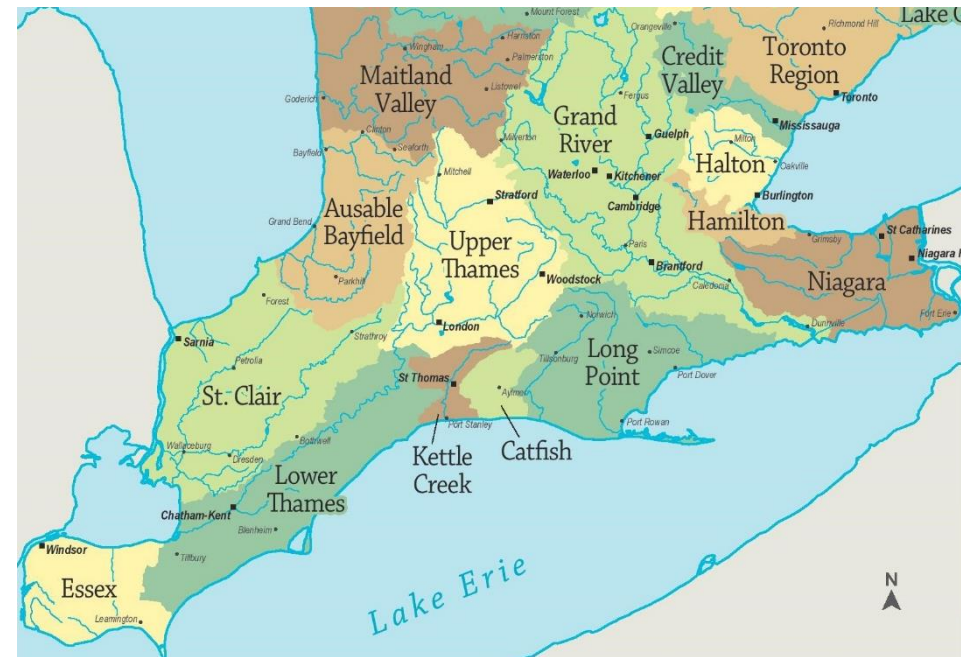
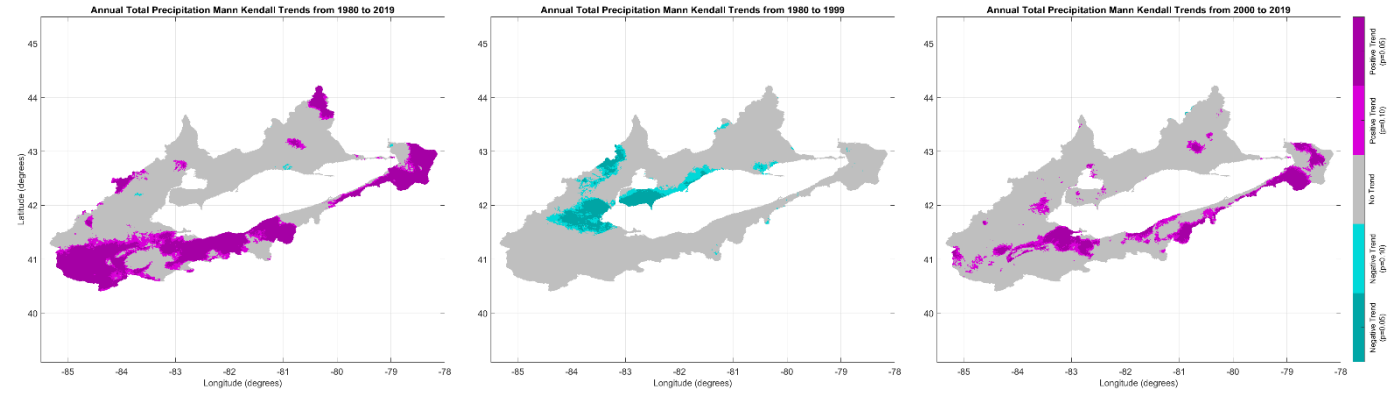
Conclusions

- Change in climate indices is not uniform across the basin for the 40-year study period
- The majority of the Lake Erie Basin is experiencing change in at least one climate index over the study period
- Understanding the spatial variability of these climate indices will help identify locations where management strategies can be implemented



Next Steps

- Evaluate shorter study periods to determine if locations without changes indicate shifting trends
- Examine the location of climate change indices compared to sub-basins (conservation authority boundaries)



Thank You!

- Dr. Geneviève Ali & Dr. Ben DeVries
- Ali Ecohydrology Lab Group
- University of Guelph
- Emotional Support Animal



NSERC
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